

International Space Station (ISS)
Common Communications
for Visiting Vehicles
(C2V2)

Draft Statement of Work
(SOW)

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1 Statement of Work Scope

This Statement of Work (SOW) defines the requirements for the design, development, test, certification, and delivery of the International Space Station (ISS) Common Communications for Visiting Vehicles System (C2V2).

1.1 Scope

The scope of the Contractor's tasks includes all labor, materials, travel, facilities, and integration functions necessary for compliance to this SOW. The C2V2 Contractor shall design, manufacture, certify, and deliver a two-way communications system that provides communication coverage for the required data types throughout rendezvous, departure, attached, and proximity operations as specified in this SOW. The Contractor shall deliver flight-certified hardware and software and associated ground support equipment, including training hardware, functional equivalent units, and qualification units. The Contractor shall perform all work necessary to satisfy the requirements in this SOW.

1.2 System Description

The C2V2 is a two-way communications system for use between the ISS and Visiting Vehicles (VVs) during rendezvous, proximity, departure, and docked operations. C2V2 terminology is contained in SOW Appendix A.

Space Station Program (SSP) Document 50808 (SSP 50808), ISS to Commercial Orbital Transportation Services (COTS) Interface Requirements Document (IRD), defines the requirement for two-way communications between the ISS and VVs. Communication is required to provide the following primary data exchanges:

- Two-way audio between crewmembers on the ISS and the VV for crewed VVs
- VV and ISS navigation data exchange for all VVs
- Commands from the ISS to the VV for uncrewed VVs
- Other two-way data exchanges for situational awareness and to support vehicle operations

The C2V2 must provide communications coverage throughout the required VV trajectories and during docked operations for all identified docking ports and trajectories. The C2V2 requirements were derived from the concept of operations documented in JSC 65991, Concept of Operations (ConOps) for the International Space Station Common Communications for Visiting Vehicles (C2V2) System. See Appendix A, Figure SOW-1, for a depiction of the high-level C2V2 project scope.

2 Requirements

2.1 Project and Contract Management

2.1.1 Project Management

The Contractor shall plan, organize, control, and report on all activities required by this contract to assure accomplishment of all outcomes and deliverable products required by this contract.

2.1.2 Business Management

The Contractor shall provide overall contract management and administration for this contract. The Contractor shall perform all business and administrative functions and integrate these functions across all areas of performance. The Contractor's on-going business analysis shall support the ISS Program business process.

2.1.3 Contract Work Breakdown Structure (WBS)

The Contractor shall develop, provide, and maintain a contract WBS dictionary per the Data Requirements Document (DRD)-TBD, WBS Dictionary. The contract WBS shall serve as the framework for contract planning, budgeting, cost reporting, schedule resource loading, and schedule status reporting to the ISS Program.

2.1.4 Financial Reporting

The Contractor shall utilize a contract financial system which discretely tracks resources by fund source, contract WBS, and elements of cost including labor, overhead, other direct costs (i.e. travel and subcontracts), and indirect costs. The Contractor shall provide financial planning for NASA-JSC budget processes (e.g., program planning, budgeting, and execution budget calls), and special requests for budget impacts. The Contractor shall provide financial reporting in accordance with the DRD-TBD, NF533 Monthly Cost Reporting. The Contractor shall include financial reporting requirements in any subcontracts for all tiers of subcontracts with annual expenditures of \$1 million or more.

2.1.5 Contract Performance

The Contractor shall use an earned value measurement system in accordance with contract Section I-Contract Clauses. The Contractor shall provide a contract performance report per DRD-TBD, Contract Performance Report.

2.1.6 Scheduling

2.1.6.1 Integrated Master Schedule

The Contractor shall update the Integrated Master Schedule (IMS) that was submitted with the proposal within thirty (30) calendar days of contract award. Thereafter, the IMS shall be updated in accordance with the DRD-TBD, Monthly Project Report. The IMS is a management tool to monitor project progress in meeting measurable project events. The Contractor shall provide NASA-JSC electronic access to the IMS. The schedule shall be in Microsoft Project format to maintain compatibility with the C2V2 project schedule.

2.1.6.2 IMS Characteristics

The Contractor's IMS shall have the following characteristics:

- The IMS shall be consistent with the contract WBS.
- The IMS shall be sufficiently detailed so that critical and high-risk efforts are identified and mitigation efforts planned as realistically as possible to ensure project execution. The IMS will be extended and expanded as the contract, options, or agreements unfold and additional insight is needed.

- The IMS shall include all activities, including Contractor, supplier, and subcontractor. The IMS shall designate the critical path and external dependencies. The IMS shall also include, but not be limited to: engineering development tasks, Contractor tests, design reviews, production and delivery schedules with planned vs. actual, key milestones, Government tests, design and technical reviews, in process reviews, and Project Management Reviews (PMRs).
- The IMS shall present a current, integrated view of the contract or agreement that is consistent with resource plans, contract performance reports, and other approved documentation.

2.1.7 Integrated Data Environment (IDE)

The Contractor shall implement an Integrated Data Environment (IDE) to support effective communication and timely exchange of information. The Contractor shall submit data in electronic format by posting it on a secure Contractor-managed IDE.

2.1.8 Integrated Product Team

The Contractor shall utilize an integrated product team approach for project execution, which includes NASA-JSC personnel for insight into:

- design, development , supportability, and verification progress
- risk management
- issue resolution
- performance, schedule, and cost status

2.1.9 Meetings and Reviews

2.1.9.1 Meetings

2.1.9.1.1 Contract Kickoff Meeting

The Contractor shall conduct a Contract kick-off meeting within thirty (30) calendar days after contract award. The location is to be negotiated between the Contractor and NASA-JSC Contracting Officer Technical Representative (COTR). Teleconference capability is to be provided by the organization hosting the meeting. Key project personnel from both NASA-JSC and the Contractor shall participate. The purpose of the meeting is to review all top level requirements, communications plan, IDE, POCs, WBS, data requirements content, all deliverables, IMS, and milestone reviews plans.

2.1.9.1.2 Teleconferences

The Contractor shall participate in a weekly status teleconference with NASA-JSC that includes the following:

- Status of previous week's activities
- Planned activities for current week
- Contractor required inputs from NASA-JSC
- NASA-JSC required inputs from Contractor
- New issue identification and description

- Action status changes
- Special topics as request by the COTR or Contractor project manager

2.1.9.1.3 Technical Interchange Meetings

The Contractor shall participate in quarterly Technical Interchange Meetings (TIMs) at NASA.

2.1.9.1.4 Participation in Other Meetings

The Contractor shall participate in monthly NASA-called technical meetings with the providers of the ISS-C2V2 Interfacing Assemblies.

2.1.9.2 Milestone Reviews

2.1.9.2.1 C2V2 Milestone Reviews

For each hardware and software deliverable item type, the Contractor shall conduct the milestone reviews identified below per the schedule provided in contract Section J-List of Documents, Exhibits, and Other Attachments, and generate review data packages in accordance with the DRD-TBD, Review Data Package.

- Requirements Review
- Preliminary Design Review (PDR)
- Critical Design Review (CDR)

For each hardware and software (as applicable) deliverable item type, the Contractor shall allow NASA-JSC participation in the following Contractor-conducted reviews:

- Flight Manufacturing Readiness Review (MRR)
- Qualification and acceptance Test Readiness Reviews (TRRs)

The Contractor shall conduct a Functional Configuration Audit/Physical Configuration Audit (FCA/PCA) per DRD-TBD, FCA/PCA for each deliverable item type.

In accordance with required delivery schedules, deliverable item types may be combined into single reviews. The Contractor shall conduct reviews in accordance with NPR 7120.5D, NASA Space Flight Program and Project Management Requirements.

2.1.9.2.2 Action and Review Items

NASA-JSC shall have the opportunity to submit action and review items on any issues identified during any of the milestone reviews. The Contractor shall close action and review items by obtaining the initiator's concurrence on the closure plan. The Contractor shall provide NASA-JSC access to all action and review items, their closure plan, and the closure product. The review board must concur on all action and review item closures and on successful completion of the review.

2.1.9.2.3 Participation in Other Reviews

The Contractor shall provide inputs to and participate in NASA-ISS C2V2 reviews associated with the C2V2 project. The Contractor shall allow NASA participation in Subcontractor reviews including the submittal of action and review items. The Contractor shall review and provide inputs to ISS-C2V2 Interfacing Assemblies specifications.

2.1.9.3 Project Management Reviews (PMRs)

The Contractor shall conduct quarterly PMRs and provide monthly integrated management review products in accordance with DRD–TBD, PMR Content, for the work performed on this contract. The reviews shall provide the ISS Program insight into the Contractor's and Subcontractors' overall technical, schedule, and cost performance.

2.1.10 Configuration Management (CM)

The Contractor shall utilize a configuration management (CM) system consistent with the requirements defined in SSP 41170, ISS Program Configuration Management Requirements.

The Contractor shall support a NASA-JSC review of the Contractor's CM system and procedures to assess compliance to the Contractor's CM plan.

The Contractor shall develop, implement and administer configuration management operations in accordance with SSP 41170, ISS Program CM Requirements. The Contractor shall develop and maintain a CM Plan in accordance with DRD-TBD, Configuration Management Plan.

2.1.10.1 Configuration Item Identification

The Contractor shall identify configuration items as specified in SSP 41170, Section 3.3.4, Configuration Item Selection.

2.1.11 Risk Management

The Contractor shall conduct regular risk assessments of cost, schedule, and performance requirements. This includes the following:

- Identify project cost, schedule, and performance risks
- Perform risk assessment using techniques included in the risk management process
- Analyze risk level ratings and prioritize risks for follow-on handling

The Contractor shall provide NASA-JSC participation in Contractor risk board meetings. The Contractor shall submit a risk management plan in accordance with DRD-TBD, Risk Management Plan.

2.1.12 System Engineering Management

2.1.12.1 System Engineering Management Plan

The Contractor shall prepare, implement, deliver, and maintain a Systems Engineering Management Plan (SEMP) in accordance with DRD-TBD, SEMP, to reflect the Contractor's selected method of management operation for the C2V2 project.

2.1.12.2 Technical Baseline Progression

The Contractor shall utilize a technical management approach that provides NASA-JSC information on design modification decisions and their impact on performance of the C2V2 system.

2.1.12.3 Traceability Documentation

The Contractor shall maintain documentation and information to allow tracing technical requirements stated in this SOW to the drawings, material, processes, and specifications. This documentation and

information shall be made available to NASA-JSC for reviews in accordance with the program approved CM plan.

2.1.12.4 Technical Performance Measurement (TPMs)

The Contractor shall utilize TPMs to maintain status of the C2V2's key technical performance areas. The Contractor shall define, with NASA-JSC coordination, the TPMs. The Contractor shall recommend changes to the TPMs as the system matures. The Contractor shall present TPM data to NASA-JSC at each monthly program review.

2.1.13 Export Control Management

The Contractor shall comply with the export control requirements in accordance with NASA Federal Acquisition Regulations Supplement clause 1852.225-70, Export Licenses.

2.1.14 Information Technology

The Contractor shall develop and implement an Information Technology (IT) Management Plan per the DRD-TBD, IT Management Plan. The Contractor shall develop and implement an IT Security Plan in accordance with DRD-TBD, IT Security Plan.

2.1.15 Communications Security

The Contractor shall meet Communications Security (ComSec) requirements for handling, storage, tracking, and shipment of ComSec material in accordance with issuances of the Committee on National Security Systems. The Contractor shall complete the required training and certification to handle the ComSec device and demonstrate compliance to the applicable security requirements. This Contractor shall have a ComSec account and custodian. NASA-JSC is responsible for obtaining keying material and the key management plan.

2.2 Safety and Mission Assurance

2.2.1 S&MA Management

The Contractor shall develop, maintain, and implement a Safety and Mission Assurance (S&MA) Plan in accordance with NASA Procedural Requirement (NPR) NPR 8715.3, NASA General Safety Program Requirements, and DRD-TBD, S&MA Plan. The S&MA Plan shall contain S&MA management; risk management; ISS safety program; reliability and maintainability; quality assurance; and operations safety.

2.2.2 Safety and Health

The Contractor shall develop, implement, and maintain a safety and health program that complies with NASA Federal Acquisition Regulations (FAR) Supplement clause 1852.223-72.

2.2.3 ISS Safety Program

The Contractor shall perform and deliver safety assessments for all hardware and software sustained and developed on this contract in accordance with SSP 30599, Safety Review Process; SSP 30309, Safety Analysis and Risk Assessment Requirements; SSP 50021, Safety Requirements Document; SSP 50038, Computer Based Control System Safety Requirements Document; and DRD-TBD, Safety Analysis and

Hazard Reports. The Contractor shall investigate and report mishaps, in accordance with NPR 8621.1, NASA Procedural Requirements for Mishap and Close Call Reporting, Investigating, and Recordkeeping.

2.2.4 Reliability and Maintainability

The Contractor shall develop, maintain and deliver the Failure Modes and Effects Analysis (FMEA) and Critical Items List (CIL) Report and worksheets in accordance with SSP 30234, Failure Modes and Effects Analysis and Critical Items List Requirements for Space Station, and the DRD-TBD, Failure Modes and Effects Analysis (FMEA) and Critical Items List (CIL), for hardware developed or sustained under this contract.

2.2.5 Quality Assurance

The Contractor shall develop, implement and maintain a quality assurance plan, as documented in the S&MA Plan in accordance with the DRD-TBD, S&MA Plan, and SSP 41173, Space Station Quality Assurance Requirements.

The Contractor shall establish and maintain a Quality Management System (QMS) that complies with the Society of Aerospace Engineers (SAE) Aerospace Standard AS9100C, Quality Management Systems – Requirements for Aviation, Space and Defense Organizations. The Contractor shall report, promote and participate in the investigation and resolution of applicable problems in accordance with SSP 41173, Space Station Quality Assurance Requirements, and SSP 30223, International Space Station Problem Reporting and Corrective Action (PRACA).

Contractor-developed hardware and software shall be accepted in accordance with SSP 50287, Hardware/Software Acceptance Process. The Contractor shall provide an Acceptance Data Package (ADP) in accordance with SSP 30695, ADP Requirements Specification, and the DRD-TBD, ADP for Contractor-developed hardware. The Contractor shall maintain the ADP for hardware sustained or maintained on the contract.

2.3 C2V2 system

2.3.1 Technical characteristics

The Contractor shall provide a C2V2 system that meets the requirements of SSP 50930, ISS C2V2 Prime Item Development Specification (PIDS).

2.3.2 Design and Manufacturing requirements

The Contractor shall design a C2V2 system that meets all applicable requirements of the following ISS documents:

- SSP 50835, ISS Pressurized Volume Hardware Common Interface Requirements Document (CIRD) , for launch, stowage, and transportation environments
- SSP 41000, System Specification for the ISS

The Contractor shall design C2V2 Ground Support Equipment (GSE) that meets the applicable requirements of the following ISS documents:

- SSP 50004, Ground Support Equipment Design Requirements International Space Station

2.3.2.1 Non-proprietary interfaces

All interfaces between the ISS-C2V2 and the VV-C2V2 including the Radio Frequency (RF) characteristics shall be non-proprietary and fully defined and documented at the CDR such that the VV provider has the option to independently obtain a compatible interfacing communication device.

2.3.2.2 Software Tools and Operating System

The Contractor shall use non-proprietary, commercially available software development tools and operating system for any flight software.

2.3.2.3 Frequency Authorization

The NASA-JSC frequency manager will obtain frequency authorization from the National Telecommunications and Information Administration (NTIA). The Contractor shall support these NTIA frequency authorization activities by providing technical review of and inputs to the authorization requests. The frequencies utilized for C2V2 are not final until NTIA frequency authorization is approved. The approved frequencies will be documented in SSP 50930, ISS C2V2 PIDS. The Contractor shall ensure frequency management requirements, policies and procedures, and RF allocation and assigned authorizations are properly followed.

2.3.2.4 Communications Security

The ISS-C2V2 and VV-C2V2 shall be designed for removal of the ComSec materials for ground transportation and testing of the C2V2 system with all capabilities enabled except data encryption and decryption and without ComSec handling restrictions.

2.3.3 Deliverables

2.3.3.1 Data

The Contractor shall complete and deliver data products in accordance with the Data Requirements List (DRL) and DRDs contained in contract Section J-List of Documents, Exhibits, and Other Attachments.

2.3.3.2 Hardware

The Contractor shall deliver the C2V2 hardware items specified in contract Section B-Supplies or Services and Prices/Costs and Section F-Deliveries or Performance.

2.3.3.2.1 Qualification and flight units

The Contractor shall design and build the C2V2 qualification and flight units in accordance with this SOW and the requirements specified in SSP 50930, ISS C2V2 PIDS hereafter referred to as the C2V2 PIDS.

Both the Qualification Units (QUs) and the Flight Units (FUs) shall be Class I equipment as defined in contract Section F-Deliveries or Performance. The QUs and FUs design shall be configuration controlled. The QUs and FUs shall be manufactured under quality control per the quality assurance plan with complete records of unit manufacturing, testing, shipping and handling.

2.3.3.2.2 Engineering units

The Engineering Units (EUs) shall incorporate C2V2 PIDS technical requirements identified at PDR as requiring demonstration prior to CDR.

The EU refers to the hardware, firmware, and software that are functionally equivalent to the flight unit. This unit is used for proof of concept testing of the detailed design and early integration testing with the ISS interfacing systems. It may be used for verification credit after CDR with quality controls as defined in the approved verification plan(s). The EU is a contract deliverable to NASA-JSC, and the Contractor shall maintain the EU and its development environment throughout the life of this contract.

2.3.3.2.3 Functional equivalent units

The Functional Equivalent Units (FEUs) shall meet all performance requirements from the C2V2 PIDS. Environmental workmanship testing is not required. Equivalent parts and processes can be only used if agreed to by the COTR/CO. The Contractor shall document all differences between the FEUs and the FUs.

2.3.3.2.4 Training units

The training units shall be form and fit identical to the flight units. The training units will be used for fit checks in ISS mock-ups and for crew training of the on-orbit installation procedures. The C2V2 mock-ups needed for Neutral Buoyancy Laboratory crew training will be provided by the Extravehicular Activity (EVA) Project Office based on Computer-Aided Design (CAD) models, the DRD-TBD, CAD models, provided by the C2V2 Contractor.

2.3.3.2.5 Ground support equipment

GSE shall be capable of supporting operations and maintenance, including unit functional checkout, configuration, and diagnostics. The GSE shall include the necessary components to emulate all external electrical and data interfaces, perform stand-alone testing and operation of the unit, and display quick look data for configuration or checkout. Equipment specifications shall be provided.

2.3.3.2.6 Critical spare components

Critical spare components shall be provided to ensure the C2V2 remains functional for specified lifetime requirements as defined in the C2V2 PIDS. Additional or replacement parts for the FUs or the FEUs shall also be provided to mitigate parts obsolescence risks.

2.3.3.3 Software and Firmware

Non-flight software, source code, firmware, development environment specifications, and the documentation necessary to test, verify, operate, and service the EU, FEU, FU, QU, and GSE shall be delivered along with the appropriate hardware deliveries. Non-flight software shall be capable of unit configuration, and problem diagnosis. Firmware and software shall be delivered in its native format, along with a complete description of the firmware development environment and specifications.

The flight software shall meet the requirements of the C2V2 PIDS. Flight software documentation shall be delivered per the DRD-TBD, Version Description Document (VDD), DRD-TBD, Software Requirements Specification, and DRD-TBD, Software Users Manual.

2.3.4 Delivery

The Contractor shall deliver the C2V2 software items specified in contract Section F-Deliveries or Performance.

2.3.4.1 Hardware

Packaging, handling, transportation, and marking shall be in accordance with the contract Section D-Packaging and Marking.

2.3.4.2 Software

The Contractor shall deliver on-orbit modifiable software to the ISS Mission Build Facility (MBF) in accordance with MBF delivery requirements defined in SSP 50482, ISS Software Management Plan, Section 5.

2.3.5 Operations and Sustaining

2.3.5.1 Post DD250 (Material Inspection and Receiving Report) Delivery

The Contractor shall sustain all hardware and software deliverables until formal transition of sustaining responsibility to the ISS sustaining teams. The Contractor shall support mission operations for installation, check-out, and first operational use of C2V2 per the milestones identified in contract Section J-List of Documents, Exhibits, and Other Attachments.

Post DD250 of the flight software delivery, the Contractor shall utilize the ISS Software Change Request (SCR) process for tracking, analysis, and closure of all issues associated with the Contractor-delivered flight software. This includes support to software control panel and avionics and software control board meetings associated with any SCRs identifying the C2V2 flight software as an effected item. Additionally, the Contractor shall participate in the review and disposition of Station Program Notes (SPNs) associated with the operation of the C2V2 software.

2.3.5.2 Sustaining Transition

Post DD250, the Contractor shall transition the sustaining engineering, logistics, and maintenance roles to the applicable ISS teams. The Contractor shall provide the products and data required to support repair transition per SSP 50276, Depot/Manufacturing Facility Certification Plan. The Contractor shall include the data content and delivery formats necessary to transition the sustaining engineering role to NASA-JSC.

2.4 ISS Integration

The Contractor shall review impacted or newly developed ISS interface documents, specifications, operations products, training products, and design documents associated with C2V2 in accordance with the DRD-TBD, ISS integration Products. The Contractor shall coordinate with the software development, data integration, vehicle, operations, quality, configuration management, and safety teams as required for integration of C2V2 into the ISS baseline and operations.

2.5 VV Integration

The Contractor shall provide inputs to and review of VV documentation related to C2V2 integration and utilization. The Contractor shall provide inputs to and attendance at VV TIMs associated with C2V2. The Contractor shall coordinate with the VV provider on C2V2 related matters.

Appendix A: C2V2 Terminology

The following terminology is utilized in this SOW:

- **C2V2 System** includes all flight equipment deliverables plus associated Ground Support Equipment (GSE) and integration activities for both the ISS and VV:
 - **ISS-C2V2 Subsystem** includes the ISS operational configuration
 - **ISS-C2V2** includes those items delivered by the Contractor for installation on the ISS.
 - **ISS-C2V2 Interfacing Assemblies** includes all interfacing cables and structures developed uniquely for interfacing the C2V2 to the ISS that are not provided by the Contractor. These items are the responsibility of NASA-JSC.
 - **VV-C2V2** includes all items delivered by the Contractor for installation in the VV. The design and development of the VV-C2V2 is included in the Basic Contract. The majority of the VV-C2V2 deliverables are included as part of Option B as designated in this SOW.

Figure SOW-1 depicts the high-level C2V2 project scope.

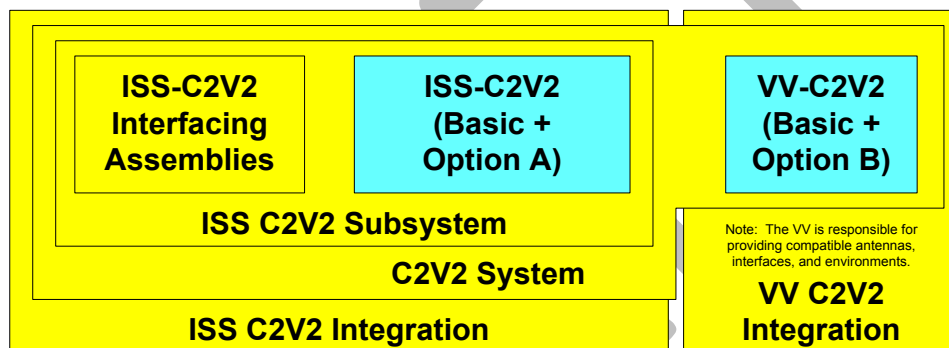


Figure SOW-1: C2V2 Project Scope